Sustainable Energy Strategy for Slovenia – Considering Core Factors for its Development

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Abstract: In this paper, current energy policy of Slovenia is analysed, renewable energy sources (RES) potentials are evaluated and examined and new possibilities for the development of alternative energy policy and for transition of Slovenian energy industry into sustainable energy industry are proposed and cross compared. On the basis of current and future electricity consumption, evaluated RES potentials and calculated investment prices, new possibilities for alternative investments projects and for alternative development of more sustainable energy policy in Slovenia are identified. Identified possibilities and current energy policy are analyzed and cross-compared from the economic and environmental viewpoint. At the end of the paper, the costs for implementation of proposed alternative energy policy investments are evaluated, calculated and cross-compared and pros and cons of alternative energy policy are evaluated.

Keywords:energy policy, sustainable energy, renewables, renewables potentials, Slovenia.

1. Introduction

Pollution, greenhouse gas emissions (GHG), rising energy demand and high import energy dependency present the core of energy problems both in the European Union (the EU) as a whole as well as in Slovenia. The current energy import dependency in the EU and in Slovenia is approximately 50% [1]. This dependency, which causes economic, political and social vulnerability of the EU, must be seen as a challenge and opportunity for sustainable development of energy policy.

Renewable energy sources (RES) are seen as a long-term solution and a short-term reduction of the above stated problems. The EU is aware of the issues related to conventional energy sources (CES) and it supports the development of RES and sustainable energy policy. Sustainable energy policy means an effective provision of energy in order to meet the needs of the present without compromising the ability of future generations to meet their own needs. Sustainable energy comprises two key components; namely, energy efficiency (EE), i.e. efficient energy consumption and RES. The investments in EE and RES are highly important since RES cause little (or no) pollution and enable the use of local resources. In addition, they decrease import dependency and increase the EU competitiveness at the same time. Since energy sector (excluding transport) is the largest producer of GHG emissions (approximately 59% of all GHG emissions) in the EU and in Slovenia [1-2], the EU intends to lower CO_2 emissions by 20% while increasing the share of RES up to 20% and enhancing EE for 20% by 2020. These goals are better known as 20/20/20 objectives and are integrated in Directive 2009/28/EC. Directive 2009/28/EC within the climate and energy package is mandatory for Slovenia as well. Slovenia's goal is to have 25% of RES in final energy consumption by 2020. Although 20/20/20 objectives are well set at the EU level, there is a lack of common strategy for their implementation since the implementation strategy remains within the competence of an individual Member State.

In Slovenia, the implementation strategy is laid out in the National Renewable Energy Action Plan (NREAP) [3] and National Energy Programme (NEP) [4]; however, these documents are not fully consistent with the 20/20/20 objectives because it does not foresee any active increase in the share of RES and EE with regard to long-term energy industry development. Furthermore, the document does not include any implementation measures, which are the most problematic for achieving sustainable energy industry.

Current and future researches on the field of sustainable energy policy are very well grounded by many studies and researches, because sustainable development is becoming very important new development paradigm, important for policy, science and public. Studies and researches have been carried out for universal (global) sustainable energy development e.g. developing strategies for sustainable energy development [5], planning regional energy development, concerning RES and environmental constrains [6], Delphi study about possibilities for future energy development [7], analysis and modelling of sustainable energy planning [8], study about facing world thirst for energy [9], assessing the impact of renewable energy deployment on local sustainability [10], examining global trends in investments in clean energy [11] etc. and for sustainable energy development in specific countries or regions e.g. modelling of renewable energy in India in 21st century [12], scenario analysis of energy policy development in Slovenia [13], study about sustainability issues in planning local energy policy [14], examining possibilities to model 100% renewable solutions for Denmark [15], development of new energy development paradigm for Turkey [16], study about possibilities for sustainable energy policy development in Slovenia [17] etc.

2. Experimental

The purpose of paper is, therefore, to evaluate the potentials, the possibilities and the options for the restructuring of Slovenian energy industry into a sustainable energy industry, consistent with the 20/20/20 goals and focused on RES, EE and reduced energy consumption. By studying the available information and literature, current situation was studied and future energy consumption was forecasted. Pros and cons of current and alternative energy strategy were analyzed.

Statistical data presented in the study are gathered on the base of compilation method. Different independent sources (statistical offices, national, international and private studies and analysis, scientific papers and national energy balances) were used. Data of energy consumption, RES share and RES potentials (exploited and unexploited), barriers of RES exploitation and all others data are statistically analyzed, evaluated and cross-compared.

Based on evaluated RES potentials, analyzed investment costs and identified possibilities for investments in RES proposal of an alternative strategy, which is more sustainable and more consistent with the 20/20/20 objectives, was made. Furthermore, both strategies and possibilities are compared in order to demonstrate the economic acceptability of RES. The comparisons are grounded on the assumptions that the achievement of the 20/20/20 objectives is the priority of Slovenian energy industry and that the price of emission allowances will rise by 2020. It has to be pointed out that our paper focuses on electrical energy only. The possibilities, the proposals, calculations and the results presented in this paper are mainly based on the installed power and not on the actual produced electricity.

The survey and analysis of Slovenian RES potentials is held on the basis of currently established economical, technological and environmental acceptability. We assume that technological and economic RES potential will increase in the future due to technological development, internalization of external costs and increased prices of fossil fuels but the environmental potential will be reduced because of stricter environmental requirements.

3. Review of the current energy policy in Slovenia and identification of available alternatives

Energy consumption in Slovenia has been growing from 2000 to 2006 and then it decreased, mainly because of the economic crisis. In order to reach the 20/20/20 objectives, it is necessary to curb and reduce energy consumption. We anticipate that a medium-term reduction of fossil fuel consumption will result in a higher growth of electricity consumption in comparison with other fuels.

Electricity consumption per capita and the share of renewables in electricity production are presented in Figure 1. Figure 1 clearly shows that, on the one hand, energy consumption grew strongly between 2000 and 2005 and has remained almost the same from 2005 to 2008. After 2008 it has decreased, mostly due to the current economic situation. On the other hand, the share of RES has been fluctuating and was in 2009 just little above 2000 level. However, RES share is growing constantly from 2007-2010. This is also partly a consequence of smaller energy consumption due to economic crisis. Because energy produced from RES grew and energy produced from fossil fuels decreased, RES share increased. Thus, the changes in energy consumption must be considered in planning long-term energy strategy and continuous growth of RES share and continuous decrease of energy use must be planned and implemented.

The current energy strategy is not designed to address the reduced and more efficient energy consumption, but it rather fills the gap between supply and demand with a new thermoelectric power plant (TPP), which also leads to high emissions and causes the reduction of needs for renewables and reduction of available capital for investments in RES. The new block of the thermoelectric power plant Šoštanj (i.e. TPP Šoštanj), which is to be built by 2015, will undoubtedly strengthen the dependence on fossil resources and will make the achievement of the 20/20/20 objectives very difficult or impossible since the lignite-fired TPP in Slovenia is responsible for about 31% of all GHG emissions in Slovenia [18].

The new lignite-powered block will be more efficient and consistent with the Directive for Integrated Pollution Protection and Control (IPPC - Directive 96/61/EC) and its key principle, i.e. best available techniques (BAT). Although it will cause less emission than the current blocks and its efficiency will be 43% (current overall average efficiency is approximately 32.4%), it will nevertheless use a fossil fuel as source of energy, which is unsustainable and will also result in high GHG emissions. Technology of coal dust firing with supercritical parameters, which will be used in TPP Šoštanj 6 (BAT for lignite TPP), will result in 3.1 million tons of CO_2 emissions annually. The justification for the investment in TPP Šoštanj 6 is argued with 43% efficiency, which can only be achieved with at least 600 MW block. 43% efficiency is, through the BAT, precondition for European Investment Bank loan. Instead of analyzing and forecasting needs and consumption of Slovenia and developing new jobs in RES sector, social problems of the region and already paid-up funds (more than EUR 200 million, according to [20]) are also misrepresented as an argument for TPP Šoštanj 6.

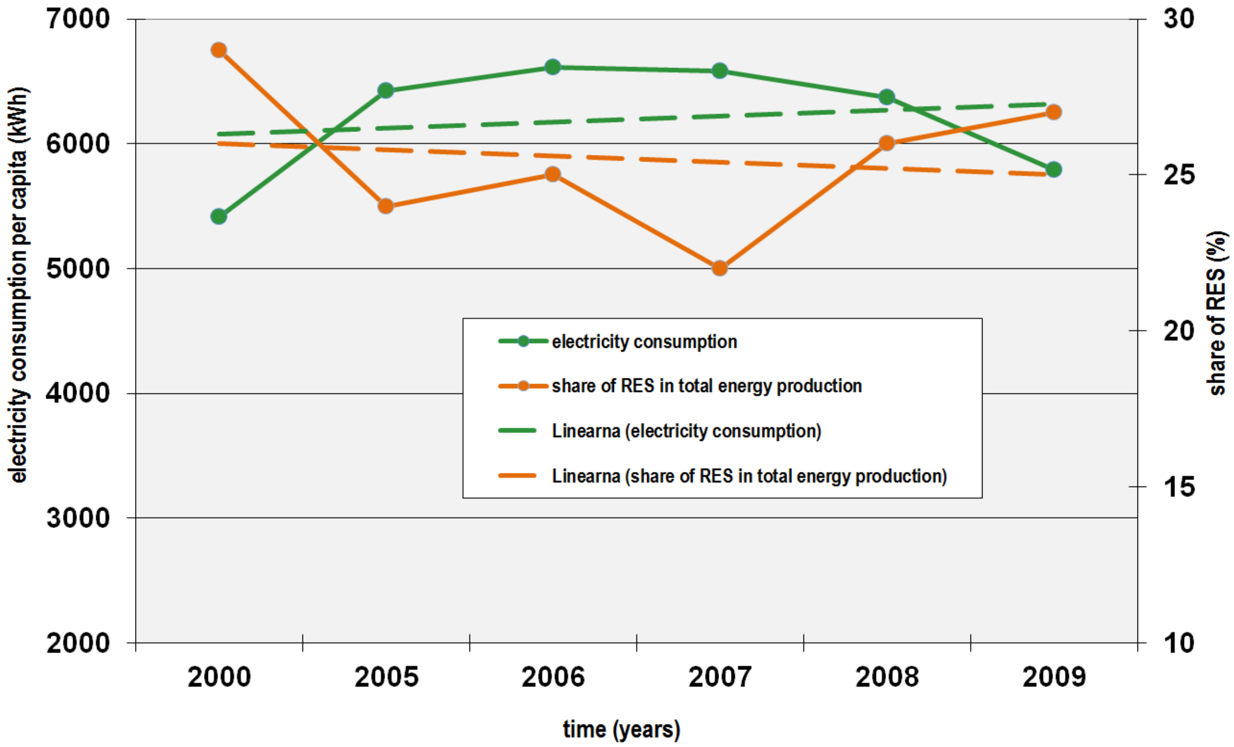

Figure 1. Electricity consumption and share of RES in total energy production in Slovenia [19].

The investment in TPP Šoštanj 6 (600 MW block) is worth EUR 1.2 billion [21] (i.e. 2 million EUR per MW), with additional investment needed for the CO_2 capture & storage technology, which has not yet been fully developed. That is why this is also an economic issue. In addition, the projections of emission allowance prices in the next 40 to 45 years (i.e. the life expectancy of TPP Šoštanj 6) are merely speculative. Time frames for the existing TPP Šoštanj blocks (TPP Šoštanj block 4 and TPP Šoštanj block 5) closure are also poorly defined. Moreover, with the construction of TPP Šoštanj 6, the existing blocks will become technologically obsolete and environmentally controversial. Namely, the three existing blocks (if still operating after TPP Šoštanj 6 will be constructed) will only increase the total GHG emissions from TPP Šoštanj.

The launch of TPP Šoštanj 6 is planned in 2015, i.e. 3 years after the cut-off date set by the Kyoto Protocol and 5 years ahead of the cut-off date for the 20/20/20 objectives. The fully operational TPP Šoštanj 6 (with TPP Šoštanj block 4 and block 5 as cold reserves) will thus make these objectives almost unattainable. Furthermore, the planned TPP Šoštanj 5 efficiency increase during the TPP Šoštanj 6 construction is also debatable if TPP Šoštanj 5 is to become a cold reserve. The investment in TPP Šoštanj 6 is based on the predicted increase of electricity use in Slovenia, which is also currently debatable (see Figure 1). It is further supported by the fact the existing TPP Šoštanj blocks are inefficient, and by the desire for energy independence. Consequently, TPP Šoštanj 6 should bridge the electricity deficit gap until new, sustainable capacities are built. However, the future of TPP Šoštanj 4 and TPP Šoštanj 5 is rather questionable since they should be gradually closed but are still to remain in cold reserve by 2027. The latter fact is the most problematic as these two blocks will become inefficient and technologically obsolete. A further concern is the adequate supply of lignite for all blocks. The current Slovenian energy strategy prefers security and adequate energy production at the expense of environmental costs. Alongside the TPPs, the construction of new hydroelectric power plants, gas-steam power plants and nuclear power plants as well as small decentralized renewables is planned. All of these are economically and environmentally more appropriate and sustainable, but are currently of secondary importance for Slovenian energy policy.

The existing energy policy is assessed as being unsustainable because it is based on the assumption of the increased energy consumption rather than on the achievement of reduced and more efficient energy consumption. It gives priority to CES, it is not oriented to the 20/20/20 objectives and it does not prefer RES. Further, it foresees a complete (unsustainable) use of lignite reserves in Slovenia and it lays too little emphasis on environmental costs.

Contrary to the current energy policy of Slovenia, sustainable energy policy must be based on reduced and efficient energy consumption as well as on the substitution of CES with RES. Namely; the central idea of sustainability is that of circular flows and self-regeneration, which cannot be achieved with fossil fuel consumption. The EU energy policy defines sustainability as the development of competitive RES and all other low-carbon sources of energy carriers by reducing energy demand within the EU and by directing the collective efforts to halt climate change and to improve local air quality. Following these three criteria, the construction of TPPŠ 6 is inappropriate. In fact, sustainable development must not be perceived as meeting the needs of the present at the expense of future generations.

Nonetheless, Slovenia is building TPPŠ 6 and abandoning the construction of new RES, mainly wind power plants and hydroelectric power plants (hydro). In general, there is a lack of active (fiscal) incentives for the construction of small and micro-scale decentralized hydro and wind power plants, however high growth can be seen in biogas and photovoltaic sector. Some RES are not merely environmentally competitive but also cost competitive with CES. Electricity generation from RES is additionally supported also by the system of guaranteed purchase price.

With an analysis and comparison of a number of indicative prices and opportunities for investment in RES in Slovenia new possibilities for investing into more sustainable energy projects are identified:

- ElektroPrimorska, for example indicates that the estimated price of wind power plants at selected locations in Slovenia ranges between EUR 1-1.37 million per MW, which is, on average, approximately 48% less than the investment in above mentioned investment in TPP Šoštanj. Although, WPPs are emission-free during the production of electricity and have low operating and maintenance costs.
- The investment in hydro varies quite substantially because of the diversity of the environment and the specificity of each project. As a rule, hydro can be divided in large hydro, small hydro and pump-storage hydro. For example, pump-storage hydro Avčecosted EUR 1.54 million per MW.
- Hydro on the Sava River cost EUR 2.63 million per MW. When discussing the operations of hydro, the minimum costs and emission-free energy production have to be taken into account. Because the hydrological potential of Slovenia is rather high, we see the great opportunities in hydro [22].
- Small hydro with current installed power of 85 MW and estimated untapped potential of 180 MW. The price for the installed MW in a small hydro is estimated at EUR 1.3-3.0 million [22-23] and depends on the size of the plant. Such power plants represent a cheap source of RES, but because they are limited in number, new RES such as biomass, solar energy and, to a lesser extent, thermal energy are becoming environmentally and economically competitive.
- Biogas plants provide a good alternative to the peak energy with investments in biogas plant around EUR 3.6 million EUR per MW of installed power. The presented calculation is the average for the biogas plants in Styria [24]. Additionally, the production of biological waste/raw materials in Slovenia is sufficient for several tens of MW of installed power in a biogas plant.
- Geothermal energy also represents an important sustainable energy source that can be used for heating purposes and for the production of electricity. However, since the geothermal potential is very difficult to evaluate since its evaluation is capitally very intensive because the evaluation is based on data gathered directly from many expensive experimental wells on different geographic areas, geothermal energy is excluded from this paper. However we believe that it has great potential since the area of Slovenia (despite the small size) partly covers the contact of two tectonic plates and this contacts are usually the places where geothermal potential is bigger than on other places.
- The investment in solar power plant is similarly high and it costs between EUR 3-4 million per MW. The annual solar radiation in Slovenia is at least 1050 kWh/m^2 (the peak is 1530 kWh/m^2) [25]; therefore, the source is sufficient and appropriate.

4. Proposal of alternative energy policy

- To achieve a long-term sustainable energy production and consumption as well as to reach the Kyoto Protocol targets and the 20/20/20 objectives, we proposed new energy policy, with priorities as presented on Figure 2 (part b).
- The proposed investments in alternative energy projects are presented on the time axis while the priorities are written from the top down. The facilities in dotted-line cells are

only an option if the energy needs arise. The reduction of energy consumption and the increased EE consumption must present the core of sustainable energy policy in Slovenia, which is also in line with the EU Directive 2006/32/EC on energy end-use efficiency and energy services (i.e. energy efficiency improvements and energy savings).Because electricity consumption declined by 4% in 2008 and by 11% in 2009 (mainly because of the economic crisis), we only have to retain the consumption at the current level, which is more favourable than reducing it. However, electricity consumption increased for app. 4% in 2010. It is also realistic to expect a small growth in electricity consumption by 2015 due to the economic recovery. In any case, this trend must be limited and reduced as much as possible already in the present.

The end-use energy efficiency improvement is also required by the European legislation. Directed by 2006/32/EC directive, Slovenia must achieve 9% energy savings by 2016 relative to the average of 2001-2005. Therefore Slovenia must increase subsidies for EE and gradually change consumer habits as these measures are the best long term opportunity for smaller and more efficient energy consumption.

The main proposed change in Slovenia's energy strategy is related to TPPŠ. By closing the existing TPP Šoštanj block 3 in 2012 instead of 2014, Slovenia would pay EUR 4.7 million less for Kyoto allowance, i.e. for the failure to comply with the Kyoto objectives. Namely, the annual TPP Šoštanj block 3 CO_2 emissions amount to 235,000 tons (according to TPP Šoštanj calculations, the price of allowance is EUR 20 per ton of CO_2).

Alternative 1 is the reconstruction of TPP Šoštanj 5 is a realistic option since electricity shortages can be replaced by pump-storage hydro Avče and the large hydro on the Sava River. The closure of TPP Šoštanj 4 is also possible after the energy plants, as presented in Figure 2, are built. Provided that TPP Šoštanj 4 is operational by 2020 (the 20/20/20 objectives) and that TPP Šoštanj 5 is operational by 2025 and that the investment in total replacement of installation and extension of activity is economically sensible, and on condition that nuclear power plant is opened, it can be estimated that TPP Šoštanj CO_2 emissions (including 2010) would be around 50.5 million tons, which is 75.5 million tons less than provided CO_2 emissions with operational TPP Šoštanj 6 by 2054, excluding TPP Šoštanj 5 after 2015. Namely, the annual CO_2 emissions of TPP Šoštanj 4 (317 MW) and TPPŠ 5 (387 MW) are 1.93 million tons and 2.29 million tons respectively [20]. Two gas steam power plants included in TPP Šoštanj and possible CO_2 capturing are not considered in this calculation.

The TPP Šoštanj 5 emissions would also be reduced after its renovation by an estimated 15%, i.e. to the level of TPP Šoštanj 6. Furthermore, increase of the installed power for around 50 MW as a result of better efficiency can be predicted. Study has proved that the investment in renovation or complete replacement of the installation of existing block of TPP Šoštanj is more economical than the investment in the construction of a new TPP Šoštanj block since some of the existing components can be used despite the change of technology.

For instance, the total investment in the renovation of two 400 MW blocks and modernization of the mine of the TPP Kostolac in Serbia is amounted to approximately EUR 860 million [26].

Alternative 2 for the reorganisation of TPP Šoštanj is the introduction of a power plant using several fuel types. A good example of such power plant is Danish Avedøre 2, which runs on straw, biomass, coal and natural gas. The total investment into this plant was approximately EUR 905,000 per MW and the efficiency of the plant is 50% when operating at 300 MW [26]. This kind of technology enables us to use different fuel types at the same time. This is particularly important due to the accessibility of specific local energy sources like wood biomass in Slovenia and because of gradual transition to RES and to the emission-free society, which must be the objective of Slovenian energy policy.

Another alternative to a lignite plant, alternative 3 is a gas steam power plant. An 800 MW gas steam power plant that can replace TPP Šoštanj 6 is planned in Kidričevo, with predicted investment costs at EUR 0.75 million per MW. The main advantages of a gas steam power plant are significantly lower emissions than in a lignite-fired TPP, lower investment, a possible coverage of peak energy consumption and a more reliable natural gas supply upon the completion of South Stream and Nabucco pipelines. The essential weaknesses of a gas steam power plant are the dependence on foreign sources of energy and gas price volatility. Price of natural gas does not (jet) following the price of oil and is therefore totally incompatible with oil price. Although natural gas is a CES, use of it causes lower GHG emissions than other CESs. For that reason, we see gas steam power plants as appropriate mid-term technology for transition to carbon-free energy industry. We can also increase the production of energy by improving EE of the existing gas steam power plants (and cogeneration plants) in Brestanica, Ljubljana and Maribor [17].

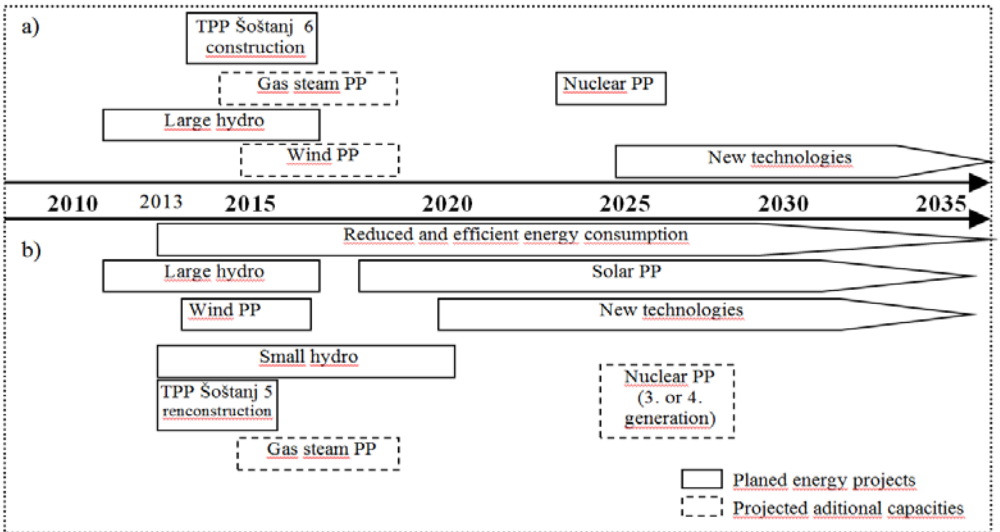

Figure 2. Estimated development of the Slovenian energy sector over time – a) existing energy strategy and b) proposed energy strategy.

However the main propose of this paper is the 4th and the most sustainable alternative to TPP – change in electricity mix and transition to RES. Because Slovenia currently does not have any wind field, ElektroPrimorska has examined the possibilities to build 180 MW of wind power plants on three wind fields in Slovenia. However, in Slovenia such possibilities are limited because appropriate geographic locations for wind power plants are few and even those which are suitable lie within the NATURA 2000 area. wind power plants construction can represent significant intervention in the environment. Although, Slovenia can achieve synergy with nature by thoughtful and sustainable positioning of wind power plants especially in degraded areas near roads. Therefore, estimation was made that Slovenia can assure 90 MW installed in WPPs.

Based on the above mentioned estimates, the investment into 90 MW wind power plants should amount to approximately EUR 105 million. Especially appropriate would be installation of a few pilot wind power plants and the examination of their operations. The results obtained would facilitate the decisions about new investments in wind power plants. Further, the criticisms of environmental organisations which do not support wind power plants in Slovenia would thus be assessed.

A large water potential of Slovenia, a high efficiency of hydro, a very long life (over 100 years) and non-emission operation together with cheap energy obtained from hydro should make investments in new hydro the priority of the Slovenian energy industry. In Slovenia, pump-storage hydro are of particular importance in the peak energy consumption, which is the most critical. New and planned pump-storage hydro facilities will supply 1300 GWh of electricity created in the peak of consumption (i.e. pump-storage hydro Avče – 178 MW and planned pump-storage hydro Kozjak 440 MW) [22]. Therefore, new suitable locations for the construction of new pump-storage hydro must be identified and considered in line with a long-term strategy, since they constitute an appropriate, reliable and clean source of peak energy. The price of investment in the pump-storage hydro Avče was EUR 1.54 million per MW [27]. The investment in large hydro on the Sava River will result in additional 482 MW of installed power [22, 27]. The average price of hydro on the Sava River's lower stream is EUR 2.63 million per MW. Additional 118 MW of power installed in hydro (Raner and Žebeljan, 2010) is also possible but environmentally highly disputable on the Soča River. Therefore hydro on Soča River are excluded from this study.

Even so, the investments in large and small hydro should, in our opinion, be a priority since such hydro can be Slovenia's biggest source of RES and can have a significant impact on mid-term replacement of CES. Small hydro with 85 MW of installed power are also very important. The water potential in Slovenia allows the construction of additional small hydro, which could produce at least 100 MW of electricity. Small hydro also have a positive impact on the decentralization of energy industry; moreover, they have the efficiency over 90% and cause less environmental strain. They can be built in many locations and require relatively small investment. For that reason, small hydro can also attract private capital. The main hindrances to building small hydro are currently low guaranteed purchase price of electricity, which is not encouraging and is annually adjusted, and the complicated procedures for obtaining the necessary documentation. To popularize small hydro, few units should be installed on the Ljubljanica River and on some other small rivers in urban areas. Because these areas are already degraded but yet, due to the movement of people and the availability, they present an optimal point for presentation to and education of the public as well as for the integration into the city electricity grid. Small hydro must be encouraged in rural regions as well because they present social benefits for rural development apart from obvious economic benefits.

Investing in 100 MW of power installed in small hydro would result in the total amount of EUR 215 million (average price EUR 2.15 million per MW). Of course, these investments are determined primarily by natural conditions. Cost reduction is possible mainly with the development of more efficient or cheaper components or by purchasing cheaper components (i.e. installations). In China and India for example, comparably efficient installations for small HEPPs cost approximately EUR 0.5 million per installed MW.

Biogas plants present the next element of energy mix for alternative 4. Biogas plants are an interesting option as they can produce trapezoidal energy. Energy sources used in biogas plants are biological waste, sludge, animal manure and energy crops. Cases from Austria and Germany, where biogas plants are more common, show us that biogas plants are very positive for the development of countryside and agriculture, too. At the same time, local sources are used and the problems of bio-waste disposal are solved. Biogas plants of 2nd generation are particularly appropriate because they use primarily wastes instead of energy crops. This is of special importance, because fields must be used for the production of food and not energy crops. Therefore, restrictions for use of crops in energy production must be made. The technology of cogeneration or three-generation enables us to achieve higher efficiency when we use generated waste heat in industry processes or for household heating. In addition, by-product is also useful as a fertilizer.

The study has proven that at least 50 MW of biogas plants can be installed in Slovenia by 2020 and the investment is evaluated at approximately EUR 180 million. Although biogas plants have social and environmental benefits, they are economical only with the support of guaranteed purchase price system; nonetheless, we need to consider the premium for the recovery of bio-waste and revenues from selling heat and fertilizer, too.

In addition, SPPs are also potentially of interest because they use free energy of the sun, but are not yet efficient enough. At present, investments in installations of solar power plants should be made only in the sunniest parts of Slovenia, not forgetting their increasing importance and greater exploitation with further development in the coming decades. In accordance with current growth of SPPs, due to guaranteed purchase prices, Slovenia can expect 50MW of SPPs installations by 2020. Total investment costs are estimated at approximately EUR 110 million, because the price of solar power plants has already significantly decreased by 2014.

Finally, the possibilities of thermal energy exploitation in Prekmurje should be explored and examined, too, primarily as a source of heating and possibly as a source for peak electricity generation as well. If the geological research and pilot projects are successful, thermal energy exploitation is sensible.

5. Conclusions

The losses of electricity as the result of the proposed transition to a sustainable energy production and consumption should be replaced with possible short-term energy imports (or less exports). We evaluate that the short term importing of energy is, due to reduced energy use possible and rational. Sustainable energy industry/policy has other benefits as well, such as lower environmental costs, less pollution, smaller penalty for failure to meet the Kyoto targets, the achievement of 20/20/20 objectives, the income from the sale of allowances, the use of local resources, sustainable economic and social development, etc.

Table 1. Summary of proposed investments in Slovenian energy industry in proposed energy strategy.

Energy source	**Wind power**	**Small hydro**	**Biogas plant**	**Solar power**	**TPP - coal**
Proposed peak power of power plant	90MW	100 MW	50 MW	50 MW	Renovation or 50% smaller installed power
Investment (million EUR/MW)	App. 1.16	App. 2.15	App. 3.60	App. 2.20	App. 2.00

The levels of GHG emissions that Slovenia would reach with the realization of the proposed energy policy would be lower for 1.7 million tons of CO_2 per year over the next 44 years simply if TPP Šoštanj 6 is not realized. The calculation based on the data from TPP Šoštanj and current and proposed energy policy has shown that the estimated energy production in TPP Šoštanj by 2020 is almost the same in both strategies.

Another calculation has shown that TPP Šoštanj operating at current capacities would produce 43 TWh of energy and 50.5 million tons of CO_2 emissions by 2025. The construction of TPP Šoštanj 6 would increase the production to 52 TWh of energy by 2025 and the resulting 49.5 million tons of CO_2 emissions. Thus, the difference in the amount of emissions is only 1 million tons although the costs for allowances are lower if the proposed energy strategy is realised without TPP Šoštanj 6.

This difference is the result of (1) the closure of TPP Šoštanj 3 in 2012 instead of 2014, and (2) the annual reduction of TPP Šoštanj 5 emissions (387 MW or approximately 435 MW after reconstruction) after 2020 as they would annually be 0.8 million tons lower than the emissions of the new TPP Šoštanj 6. However, approximately 9 TWh less energy is produced without TPP Šoštanj 6. This gab should be fulfilled with other RES as proposed.

In this paper, we proved that competitive possibilities for investing in more sustainable renewables exist in Slovenia, mainly in the form of hydro-electric power plants. From the trapezoidal energy consumption aspect, PHEPPs are the most important while small hydro are the most suitable from the environmental and social viewpoint. Namely, the latter represent only a minor interference in the environment and facilitate the development of rural areas together with the exploitation of unused water sources. However, large hydro still remain the largest energy producers from RES in Slovenia.

If the new wind power plants, small hydro, biogas plants and solar power plants are built as presented in this paper and summarized on Table 1, Slovenia could gain additional 290 MW of RES power in the value of EUR 510 million (i.e. the average of EUR 1.75 million per MW or approximately EUR 250,000 less per MW than planned in TPP Šoštanj 6), which could at least present the reduction of TPP Šoštanj 6 output in the same quantity.

Moreover, if the output of new hydro, pump-storage hydro and gas steam power plants is added, the new TPP Šoštanj block is unnecessary and inadequate from the environmental, economic and social perspectives. It is socially inappropriate also because new jobs have much greater potential in the renewable energy industry that coal industry and can minimize or even completely solve social and societal issues of the Šaleška Valley.

The development and transition of Slovenian energy industry into a more sustainable one is realistic, cost competitive and sensible. At a time when we are beginning to realize the global environmental constraints, we still base our development on a quantitative increase in the use of raw materials and energy. We have to move away from restrictive assumptions and change our patterns of thinking with regard to the energy sector and to our everyday lives as this is the only way to a sustainable energy policy. A fundamental change is needed in the mindsets of the energy policy planners as well as of the public. Therefore, the energy policy development and energy consumption should be founded on the promotion of reduced and efficient use of energy and on the awareness that the increasing consumption will undoubtedly exceed sustainable development.

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